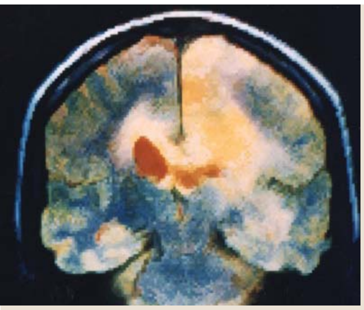
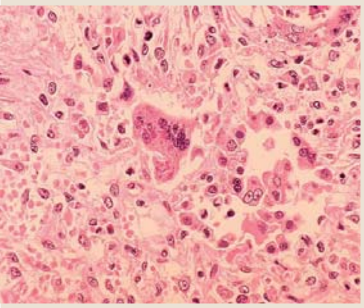
FEBRUARY 2015

Volume 22
Number 2

MSMR

MEDICAL SURVEILLANCE MONTHLY REPORT





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SUMMARY TABLES AND FIGURES

A publication of the Armed Forces Health Surveillance Center

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **FEB 2015**	2. REPORT TYPE	3. DATES COVERED **00-00-2015 to 00-00-2015**

4. TITLE AND SUBTITLE **Medical Surveillance Monthly Report**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Medical Surveillance Monthly Report (MSMR),,Armed Forces Health Surveillance Center,,11800 Tech Road, Suite 220 (MCAF-CS),,Silver Spring,,MD,20904**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
MSMR Vol. 22 No. 2 February 2015

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**20**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Whither the "Signature Wounds of the War" After the War: Estimates of Incidence Rates and Proportions of TBI and PTSD Diagnoses Attributable to Background Risk, Enhanced Ascertainment, and Active War Zone Service, Active Component, U.S. Armed Forces, 2003–2014

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"If we could first know where we are, and whither we are tending, we could then better judge what to do, and how to do it." ***—Abraham Lincoln***

Traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD) are "signature wounds" of the Afghanistan/Iraq wars; however, many TBI/PTSD cases are not war related. During the wars, diagnoses of TBI/PTSD among military members increased because risks of TBI/PTSD, and capabilities to detect cases, increased. This report summarizes TBI/PTSD diagnosis experiences of three cohorts of overseas deployers in relation to the natures of their exposures to active war service and enhanced case ascertainment efforts. The findings suggest that, during the war, the proportions of PTSD diagnoses attributable to war zone service decreased from approximately 80% to less than 50%, while the proportions attributable to enhanced case ascertainment increased from less than 10% to nearly 50%. The proportions of TBI diagnoses attributable to war zone service more than tripled from 2003–2005 (13.1%) through 2007–2009 (44.8%); the proportions attributable to enhanced ascertainment also markedly increased, but not until after 2007. By the end of the war, war zone service and enhanced ascertainment accounted for similar proportions of all PTSD and TBI diagnoses. If programs and resources currently focused on TBI and PTSD continue, rates of diagnoses post-war will greatly exceed those pre-war.

Traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD) are often considered the "signature wounds" of the wars in Afghanistan and Iraq.[1] Concerns about the acute and long-term health effects, as well as the military operational impacts, of these conditions sharply increased as the wars progressed.

In 2006, a Department of Defense (DoD) task force was commissioned to assess issues related to the mental health of military members. The task force's main findings were that stigmas related to mental health care were pervasive; that mental health professionals were not sufficiently accessible to service members; that there were significant gaps in continuity of care; and that there were insufficient mental health resources (e.g., funds, personnel). The task force made numerous recommendations aimed at these issues.[2,3]

At least partly in response to the task force's findings, the Army more than doubled the number of behavioral health workers over the next 5 years.[4] Also, the DoD implemented widespread policies and programs to reduce stigmas associated with and to eliminate barriers to seeking or receiving mental health care. In addition, the Military Health System (MHS) greatly increased resources for mental disorder and TBI-related awareness, education, screening, diagnosis, treatment, and research. By 2011, more than 200 programs sponsored or funded by the DoD specifically addressed psychological health and TBI.[5] As these policies and programs were implemented, more war service veterans, as well as service members with TBI or PTSD from other causes, were diagnosed and treated.[6-8] However, the numbers and proportions of newly diagnosed cases of PTSD and TBI that were directly related to these enhancements are unclear.

Now that direct combat missions in Afghanistan and Iraq have ended, the MHS must adapt to decreasing demands for war-specific services, such as screening, diagnosis, treatment, and rehabilitation for war-specific illnesses and injuries. However, the natures and numbers of some war-related conditions are difficult to assess because many war-related conditions also occur frequently during peace time (e.g., PTSD, TBI, anxiety, depression; sleep disorders; back, neck, and shoulder pain); as such, the proportions of all illnesses and injuries diagnosed during the war that were directly related to war zone experiences are unknown.

The analyses for this report were designed to estimate the independent effects of recent enhancements to case ascertainment efforts and, separately, of active war zone service. To this end, the PTSD and TBI diagnosis experiences of three cohorts of overseas deployers were compared: military

members who served in Korea/Japan prior to the wars in Afghanistan and Iraq; military members who served in Korea/Japan during the wars in Afghanistan and Iraq; and military members who served in Afghanistan/Iraq during the war period **(Table 1)**. Of note, those who served in Korea/Japan prior to the war were exposed to "background" (i.e., non-war-related) risks of TBI and PTSD and pre-war case ascertainment capabilities. Those who served in Korea/Japan during the war were exposed to similar (i.e., non-war-related) risks of TBI/PTSD as their pre-war counterparts; however, they were beneficiaries of the war-related enhancements to TBI/PTSD case ascertainment that were implemented during the war. Finally, those who served in Iraq/Afghanistan during the war were exposed to war-related risks of TBI/PTSD as well as war-related enhancements of case ascertainment. The contrasts in the natures of the overseas service and the case ascertainment capabilities that these cohorts experienced enable assessments of the effects of these differences on the likelihood of post-deployment TBI/PTSD diagnosis.

In general, the diagnosis of an incident case of TBI/PTSD requires that a clinically detectable, previously undiagnosed case (or in some cases, a history of a clinically significant undiagnosed case) presents to a person who is motivated, trained, and enabled to suspect and reliably diagnose the condition. As such, rates of incident diagnoses in cohorts depend on the prevalence of clinically detectable, previously undiagnosed cases in, and the scope and intensity of case ascertainment efforts that are applied to, the cohorts. Factors that increase the prevalence of clinically detectable, previously undiagnosed cases or enhance capabilities to ascertain such cases increase numbers and rates of incident diagnoses of such cases. In this report, such factors are referred to as "determinants of the likelihood of diagnosis."

The specific objectives of this analysis were to estimate, during various periods of the war, the rates and proportions of incident diagnoses of TBI and PTSD after redeployment from Iraq/Afghanistan that were attributable to three determinants of the likelihood of diagnosis of TBI/PTSD: 1) the continuation of the background risk and case ascertainment capabilities that existed prior to the war ("background risk/ascertainment"); 2) enhanced case ascertainment capabilities that were implemented during the war ("enhanced ascertainment"); and 3) service in an active war zone ("active war zone service") **(Table 1)**. The findings have practical implications because, for example, the fraction of newly diagnosed cases attributable to active war zone service, but not to the other determinants of diagnoses, will likely significantly decrease after the cessation of direct combat operations in Iraq and Afghanistan.

TABLE 1. Relationships between locations of and times of return from overseas assignments and determinants of the likelihood of diagnosis of post-traumatic stress disorder (PTSD) and traumatic brain injury (TBI), active component, U.S. Armed Forces, 2000–2013

Overseas service cohorts		Determinants of the likelihood of diagnosis		
Location	Time of re-deployment	Background risk and ascertainment	Enhanced ascertainment	Increased risk: active war zone
Korea/Japan				
	Pre-war: January 2000–August 2001	X		
	During war: April 2003–March 2013	X	X	
Iraq/Afghanistan				
	During war: April 2003–March 2013	X	X	X

METHODS

The surveillance period was 1 April 2003 through 30 June 2014. The surveillance population included all individuals who served in the active component of the Army, Navy, Air Force, or Marine Corps and were assigned to and returned from Afghanistan or Iraq and/or returned from assignments in Korea or Japan (including Okinawa) between 1 April 2003 and 31 December 2013. A "pre-war" referent population included all individuals who served in the active component of the Army, Navy, Air Force, or Marine Corps who returned from assignments in Korea or Japan (including Okinawa) between 1 January 2000 and 31 August 2001.

The unit of observation was the first 36 months after returning from a deployment of at least 30 days to Iraq/Afghanistan or Korea/Japan by an active component member with no diagnosis of the condition of interest ever prior to the post-deployment period. The conditions of interest were "traumatic brain injury (TBI)" and "post-traumatic stress disorder (PTSD)"; the ICD-9-CM codes considered indicators of the conditions of interest are in **Table 2**. Endpoints of analyses were hospitalizations or ambulatory visits with the conditions of interest as discharge diagnoses (in any diagnostic position) on standardized electronic records of subject encounters. Individuals could contribute more than one observation to the analyses.

For survival analyses, follow-up times began on the last day of each deployment of at least 30 days to Afghanistan or Iraq or on the last day of each assignment in Japan or Korea. Follow-up times ended with the earliest of the following: a medical encounter for the condition of interest; end of active military service; deployment to Afghanistan, Iraq, Korea, or Japan; or death. For survival analysis purposes, medical encounters during which conditions of interest were diagnosed were considered "failure events." All other end of follow-up time defining events were considered "censoring events."

Each war-related deployment and each assignment to Korea/Japan was characterized in relation to the gender, age group, race/ethnicity, military service branch, military occupational group, calendar year (end of deployment/assignment), and

TABLE 2. ICD-9 codes used for case definitions of traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD)

Condition	ICD-9 codes
TBI	310.2 (postconcussion syndrome)
	800.0x–800.9x (fracture of vault of skull)
	801.0x–801.9x (fracture of base of skull)
	803.0x–803.9x (other and unqualified skull fractures)
	804.0x–804.9x (multiple fractures involving skull or face with other bones)
	850.x (concussion)
	851.0x–851.9x (cerebral laceration and contusion)
	852.0x–852.5x (subarachnoid, subdural, and extradural hemorrhage, following injury)
	853.0x–853.1x (other and unspecified intracranial hemorrhage following injury)
	854.0x–854.1x (intracranial injury of other and unspecified nature)
	907.0 (late effect of intracranial injury without skull or facial fracture)
	950.1–950.3 (injury to optic chiasm/pathways or visual cortex)
	959.01 (head injury, unspecified)
	Personal history of TBI
	V15.52 (no extenders); V15.52_0–V15.52_9 ; V15.52_A–V15.52_F (currently only codes in use)
	V15.5_1–V15.5_9; V15.5_A–V15.5_F
	V15.59_1–V15.59_9; V15.59_A–V15.59_F
PTSD	309.81

number of prior Iraq/Afghanistan deployments (results not included in this report) of the subject deployer.

Separately for TBI and PTSD, survival curves were generated for all war-related deployments and Korea/Japan assignments. For each curve, the percentages "failing" (i.e., diagnosed with the condition of interest) at 1 month, 3 months, 6 months, 9 months, 12 months, 18 months, 24 months, and 36 months post-deployment/assignment were calculated. (Because 36-month follow-ups of cohorts that returned from overseas in 2012–2013 were incomplete, this report includes only survival experiences through 24 months post-deployment.)

The post-deployment TBI/PTSD diagnosis experiences of those who served in Korea/Japan prior to the war were considered the experiences that would have occurred if both war-related risks and improvements in case ascertainment had not occurred during the war period. As such, these pre-war "background" experiences were used as referent experiences for estimating the effects of wartime enhancements to case ascertainment and active war zone service.

The differences between the post-deployment diagnosis experiences of Korea/Japan service veterans during the war compared to those prior to the war ("pre-war background") were used as estimates of the rates and proportions of post-deployment diagnoses attributable to wartime enhancements in case ascertainment.

The differences between the post-deployment diagnosis experiences of Iraq/Afghanistan war zone and Korea/Japan service veterans during the war period were used as estimates of the rates and proportions of post-deployment diagnoses attributable to active war zone service.

For summary purposes, the rates of incident diagnoses (within 24 months post-deployment) during the war period that were estimated as attributable to the continuation of the pre-war background experience, enhancements in case ascertainment, or active war zone service were considered "attributable incidence rates" (expressed as percentages of re-deployers so affected). The proportions of all incident diagnoses (within 24 months post-deployment) during the war period that were estimated as attributable to the continuation of pre-war background experience, enhancements in case ascertainment, or active war zone service were considered "attributable fractions" (expressed as percentages of all post-deployment TBI/PTSD diagnoses).

RESULTS

TBI

During the war period, there were 2,020,340 deployments to Iraq/Afghanistan by active component members who had not previously been diagnosed with TBI. Within 3 years after returning from these deployments, there were 191,052 TBI diagnoses; the cumulative incidence of post-deployment TBI diagnoses was 9.46 per 100 deployments (100 dplys). Among all demographic/military subgroups of Iraq/Afghanistan deployers, the cumulative incidence of TBI diagnoses was highest among those in the Army (11.90 per 100 dplys), older than 24 years (25–35 years and older than 35 years: 10.28 and 10.32 per 100 dplys, respectively), and in combat-specific occupations (10.68 per 100 dplys) **(Table 3)**.

During the war period, there were 529,609 assignments to Korea/Japan by active component members who had not previously been diagnosed with TBI. Within 3 years after returning from these assignments, there were 26,028 TBI diagnoses; the overall cumulative incidence of post-assignment TBI diagnoses was 4.91 per 100 dplys. Among all demographic/military subgroups of Korea/Japan service veterans, the cumulative incidence of TBI diagnoses was highest among those in the Army (5.68 per 100 dplys), older than 24 years (25–35 years and older than 35 years: 5.87 and 5.92 per 100 dplys, respectively), and in healthcare occupations (5.56 per 100 dplys) **(Table 3)**.

During the war period overall, the ratio of the probability of TBI diagnosis after serving in Iraq/Afghanistan compared to Korea/Japan was 1.92 **(Table 3)**. Compared

TABLE 3. Incident diagnoses of traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD) per 100 deployments to Iraq/Afghanistan or Korea/Japan during war period, active component, U.S. Armed Forces, April 2003–December 2013

		TBI				PTSD			
		No. of follow-up segments	No. of diagnoses	Diagnoses per 100 deployments	Ratio, Iraq/Afghan: Korea/Japan	No. of follow-up segments	No. of diagnoses	Diagnoses per 100 deployments	Ratio, Iraq/Afghan: Korea/Japan
Overall	Iraq/Afghan	2,020,340	191,052	9.46	1.92	2,279,258	110,618	4.85	4.66
	Korea/Japan	529,609	26,028	4.91		577,747	6,012	1.04	
Military service									
Army	Iraq/Afghan	1,011,975	120,395	11.90	2.09	1,161,002	78,432	6.76	4.29
	Korea/Japan	211,732	12,025	5.68		232,335	3,656	1.57	
Navy	Iraq/Afghan	162,909	13,718	8.42	1.66	182,896	6,737	3.68	4.56
	Korea/Japan	40,625	2,056	5.06		43,715	353	0.81	
Air Force	Iraq/Afghan	476,821	28,950	6.07	1.18	534,815	9,083	1.70	3.18
	Korea/Japan	132,730	6,818	5.14		146,997	785	0.53	
Marine Corps	Iraq/Afghan	368,635	27,989	7.59	2.14	400,545	16,366	4.09	5.19
	Korea/Japan	144,522	5,129	3.55		154,700	1,218	0.79	
Sex									
Male	Iraq/Afghan	1,806,960	176,724	9.78	1.97	2,050,219	99,386	4.85	5.39
	Korea/Japan	449,206	22,357	4.98		493,099	4,436	0.90	
Female	Iraq/Afghan	213,380	14,328	6.71	1.47	229,039	11,232	4.90	2.63
	Korea/Japan	80,403	3,671	4.57		84,648	1,576	1.86	
Age group									
<25 years	Iraq/Afghan	887,385	74,479	8.39	2.21	934,902	42,945	4.59	5.72
	Korea/Japan	247,152	9,406	3.81		255,476	2,053	0.80	
25–35 years	Iraq/Afghan	844,601	86,821	10.28	1.75	977,702	48,197	4.93	4.35
	Korea/Japan	197,816	11,608	5.87		221,228	2,506	1.13	
>35 years	Iraq/Afghan	288,354	29,752	10.32	1.74	366,654	19,476	5.31	3.69
	Korea/Japan	84,641	5,014	5.92		101,043	1,453	1.44	
Race/ethnicity									
White, non-Hispanic	Iraq/Afghan	1,310,143	127,221	9.71	1.92	1,483,118	71,094	4.79	5.04
	Korea/Japan	300,789	15,187	5.05		328,942	3,128	0.95	
Black, non-Hispanic	Iraq/Afghan	319,896	27,793	8.69	1.75	359,159	17,791	4.95	3.81
	Korea/Japan	110,408	5,469	4.95		120,704	1,569	1.30	
Hispanic	Iraq/Afghan	213,775	21,801	10.20	2.11	240,521	13,293	5.53	4.71
	Korea/Japan	57,433	2,782	4.84		62,385	732	1.17	
Other/unspecified	Iraq/Afghan	176,526	14,237	8.07	1.90	196,460	8,440	4.30	4.84
	Korea/Japan	60,979	2,590	4.25		65,716	583	0.89	
Military occupation									
Combat-specific	Iraq/Afghan	594,414	63,503	10.68	2.17	670,003	37,647	5.62	5.46
	Korea/Japan	79,201	3,908	4.93		86,334	888	1.03	
Health care	Iraq/Afghan	122,520	12,133	9.90	1.78	136,252	11,604	8.52	5.51
	Korea/Japan	36,438	2,026	5.56		39,426	609	1.54	
Others	Iraq/Afghan	1,303,406	115,416	8.85	1.82	1,473,003	61,367	4.17	4.17
	Korea/Japan	413,970	20,094	4.85		451,987	4,515	1.00	

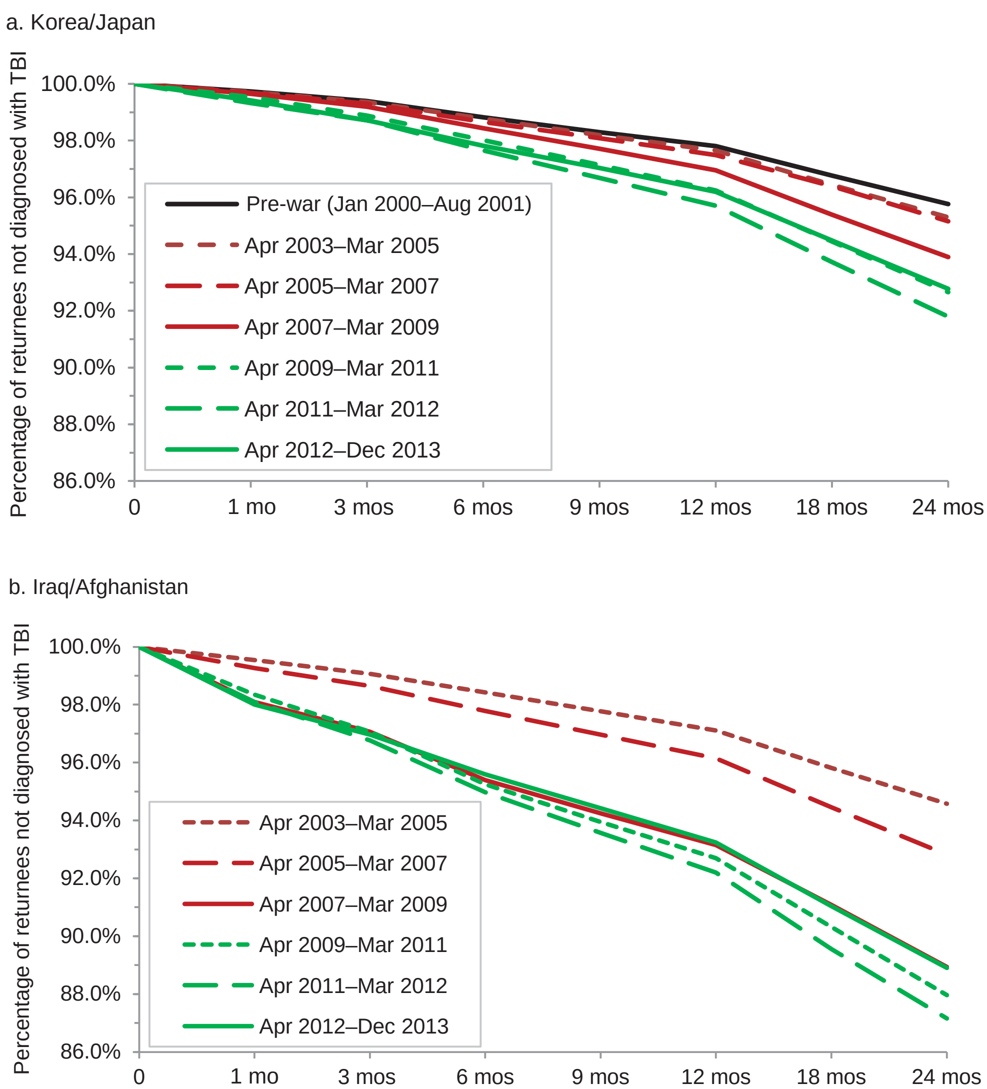
to serving in Korea/Japan prior to the war (i.e., the background experience), the ratios of probabilities of TBI diagnoses after serving in Iraq/Afghanistan or Korea/Japan during the war were 2.23 and 1.16, respectively **(data not shown)**.

TBI survival analysis: Among Korea/Japan service veterans, the estimated probability of a TBI diagnosis (within 24 months post-deployment) slightly increased from the pre-war period (4.24%) to 2005–2007 (4.84%), sharply increased from 2005–2007 through 2011–2012 (8.21%), and then slightly declined through 2012–2013 (7.23%) **(Figure 1a)**.

Among Iraq/Afghanistan war service veterans, the estimated probability of a TBI diagnosis (within 24 months post-deployment) sharply increased from the beginning of the war through 2007–2009 (11.1%), slowly increased through 2012 (12.8%), and then slightly declined through 2012–2013 (11.1%) **(Figure 1b)**.

Attributable incidence and attributable fractions: Prior to the war, the probability of a TBI diagnosis within 24 months after serving in Korea/Japan was 4.2%; this was considered the background incidence (%) of TBI diagnoses after overseas assignments in general **(Figure 2)**.

FIGURE 1. Survival analysis: estimated percentages not diagnosed with traumatic brain injury (TBI) within 24 months after returning from overseas assignments, during specified periods prior to and during warfighting, active component, U.S. Armed Forces, 2000–2013



In 2003–2005, the background incidence could account for nearly 80% of all TBI diagnoses within 24 months after returning from Iraq/Afghanistan (background incidence, attributable fraction, 2003–2005: 78.2%). Soon thereafter, however, the proportions of all post-deployment TBI diagnoses that could be attributed to background incidence rapidly declined, from nearly 80% in 2003–2005 to less than 40% in 2007–2009 (background incidence, attributable fraction: 2007–2009, 38.3%). Throughout the rest of the war period, background incidence was estimated to account for approximately one-third of all post-deployment TBI diagnoses (background incidence, attributable fractions: 2009–2011 through 2012–2013, range, 33.0%–38.2%) **(Figure 3)**.

The TBI diagnosis incidence considered attributable to enhanced case ascertainment steadily increased—by nearly eightfold overall—from the beginning of the war through 2011–2012 (enhanced ascertainment, attributable incidence: 2003–2005: 0.47%; 2011–2012, 3.97%). Enhanced case ascertainment could account for only approximately one of 12 post-deployment TBI diagnoses in 2003–2005 but nearly one-third of all such diagnoses in 2011–2012 (enhanced ascertainment, attributable fractions: 2003–2005, 8.7%; 2011–2012, 30.9%) **(Figures 2, 3)**.

The TBI diagnosis incidence considered attributable to active war zone service markedly increased from 2003–2005 (0.7%) to 2007–2009 (5.0%)—and then slowly declined through 2012–2013 (3.9%). War zone service was estimated to account for approximately one of seven post-deployment TBI diagnoses in 2003–2005, nearly half of all such diagnoses in 2007–2009, but only approximately one-third of all such diagnoses in 2012–2013 (war zone service, attributable fractions: 2003–2005: 13.1%; 2007–2009: 44.8%; 2012–2013: 34.8%) **(Figures 2, 3)**.

In two demographic/military subgroups of deployers, the TBI diagnosis incidence attributable to war zone service was estimated as at least 6.0% during at least one follow-up period (war zone service, attributable incidence: Army, 2007–2009: 8.1%; combat-specific occupation, 2007–2009 through 2012–2013, range, 6.2%–9.0%)

FIGURE 2. Attributable incidence rates (% of returnees affected), traumatic brain injury (TBI) diagnoses within 24 months after returning from Iraq/Afghanistan, by determinants of the likelihood of diagnosis, during specified follow-up periods, active component, U.S. Armed Forces, 2003–2013

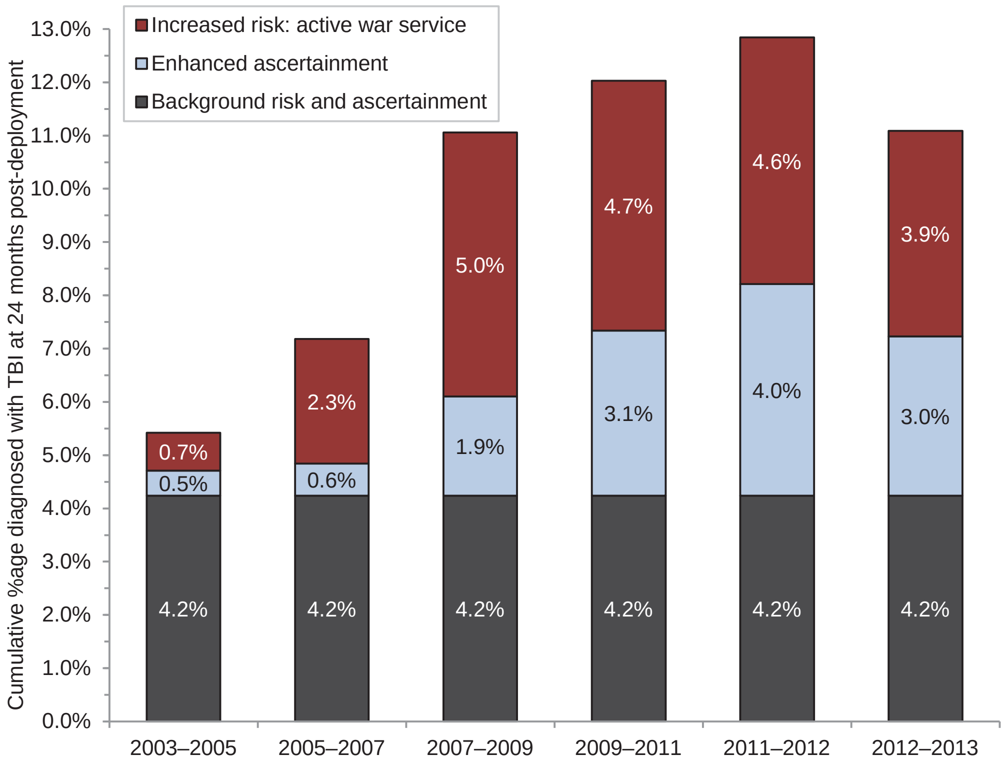
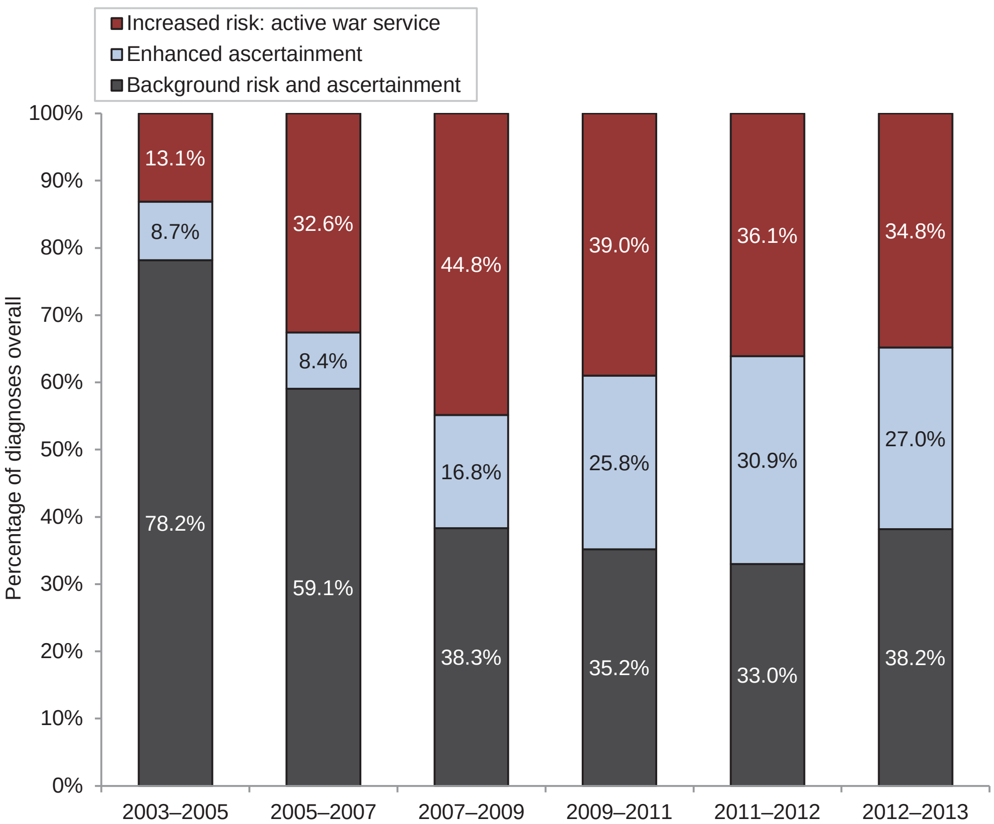


FIGURE 3. Attributable fractions (%) of all traumatic brain injury (TBI) diagnoses within 24 months after returning from Iraq/Afghanistan, by determinants of the likelihood of diagnosis, during specified follow-up periods, active component, U.S. Armed Forces, 2003–2013



(Table 4a). (See https://www.afhsc.mil/documents/pubs/msmrs/2015/v22_n02_sup_1.pdf.)

In four subgroups of deployers, war zone service was estimated to account for more than 50% of all post-deployment TBI diagnoses during at least one follow-up period (war zone service, attributable fractions: Army, 2007–2009, 50.4%; Navy, 2009–2011, 52.1%; other/unspecified race/ethnicity, 2012–2013, 56.8%; combat-specific occupations, 2007–2009 and 2012–2013, 51.6% and 67.8%, respectively) **(Table 4a)**.

In three subgroups of deployers, the TBI diagnosis incidence attributable to enhanced ascertainment was estimated as at least 5.0% during at least one follow-up period (enhanced ascertainment, attributable incidence: Army, 2009–2011 through 2012–2013, 5.3%–6.8%; older than 35 years old, 2011–2012, 5.3%; combat-specific occupation, 2011–2012, 5.1%) **(Table 4a)**.

In three subgroups of deployers, enhanced ascertainment was estimated to account for more than 40% of all post-deployment TBI diagnoses during at least one follow-up period (enhanced ascertainment, attributable fractions: Army, 2011–2012, 41.6%; females, 2009–2011 through 2012–2013, 45.1%–53.6%; older than 35 years old, 2011–2012, 41.2%) **(Table 4a)**.

PTSD

During the war period, there were 2,279,258 deployments to Iraq/Afghanistan by active component members who had not previously been diagnosed with PTSD. Within 3 years after returning from war zone deployments, there were 110,618 PTSD diagnoses; the cumulative incidence of post-deployment PTSD diagnoses was 4.85 per 100 dplys. Among all demographic/military subgroups of war zone deployers, cumulative incidence rates of PTSD diagnoses were highest among those in healthcare and combat-specific occupations (8.52 and 5.62 per 100 dplys, respectively), in the Army (6.76 per 100 dplys), and of Hispanic race/ethnicity (5.53 per 100 dplys) **(Table 3)**.

During the war period, there were 577,747 assignments to Korea/Japan by active component members who had not

previously been diagnosed with PTSD. Within 3 years after returning from these assignments, there were 6,012 PTSD diagnoses; the overall cumulative incidence was 1.04 per 100 assignments. Among all demographic/military subgroups of Korea/Japan service veterans, cumulative incidence rates of PTSD diagnoses were highest among those who were female (1.86 per 100 dplys), in the Army (1.57 per 100 dplys), and in healthcare occupations (1.54 per 100 dplys) **(Table 3)**.

During the war period overall, the ratio of the probability of a PTSD diagnosis after serving in Iraq/Afghanistan compared to Korea/Japan was 4.66. Compared to serving in Korea/Japan prior to the war (i.e., background experience), the ratios of the probabilities of PTSD diagnoses after serving in Iraq/Afghanistan or Korea/Japan during the war were 17.15 and 3.68, respectively **(data not shown)**.

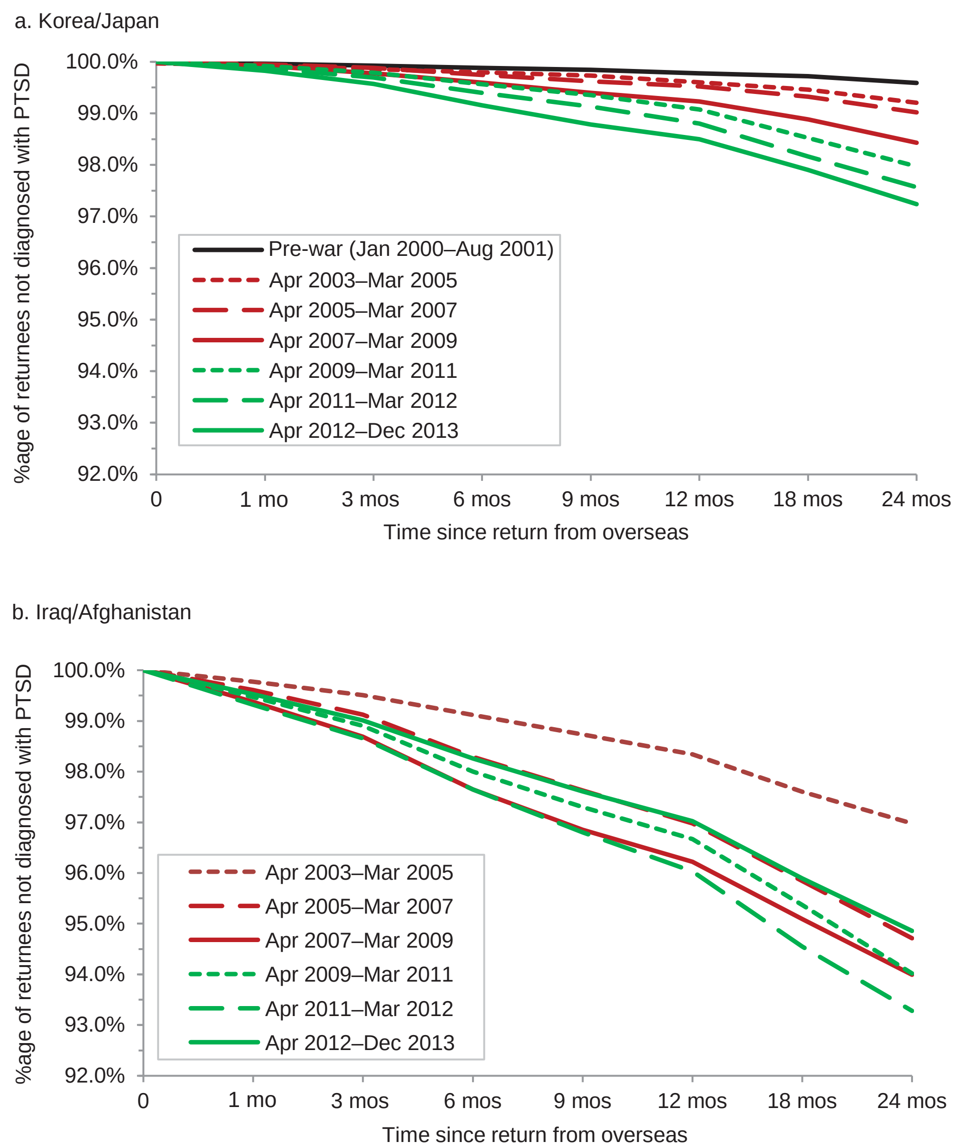
PTSD survival analysis: Among Korea/Japan service veterans, estimated probabilities of PTSD diagnosis (within 24 months post-deployment) consistently increased throughout the war period; however, the largest increase was between 2005–2007 (0.98%) and 2007–2009 (1.57%) **(Figure 4a)**.

Among war zone deployers, estimated probabilities of post-deployment PTSD diagnoses consistently and sharply increased from the beginning of the war through 2007–2009. However, compared to the 2007–2009 experience, the probability of a PTSD diagnosis was lower through 18 months, but similar at 24 months, in 2009–2011; similar through 12 months, but slightly higher at 24 months, in 2011–2012; and markedly lower throughout 24 months in 2012–2013 **(Figure 4b)**.

Attributable incidence and fractions: Prior to the war, the probability of a PTSD diagnosis within 24 months after returning from Korea/Japan was 0.28%; this was considered the background incidence of PTSD diagnoses after overseas assignments in general.

Among war zone deployers, the background incidence could account for approximately one of ten post-deployment diagnoses in 2003–2005, but only one of 20 such diagnoses throughout the rest of the war period (background incidence, attributable fractions: 2003–2005, 9.4%; 2005–2013, range, 4.2%–5.5%) **(Figures 5, 6)**.

FIGURE 4. Survival analysis: estimated percentages not diagnosed with post-traumatic stress disorder (PTSD) within 24 months after returning from overseas assignments, during specified periods prior to and during warfighting, active component, U.S. Armed Forces, 2000–2013



The PTSD diagnosis incidence considered attributable to enhanced case ascertainment steadily increased, by nearly 10-fold overall, throughout the war period (enhanced ascertainment, attributable incidence: 2003–2005, 0.26%; 2012–2013, 2.48%). Enhanced case ascertainment was estimated to account for approximately one of 12 post-deployment PTSD diagnoses in 2003–2005 but nearly half of such diagnoses in 2012–2013 (enhanced ascertainment, attributable fractions: 2003–2005, 8.6%; 2012–2013, 48.2%) **(Figures 5, 6)**.

PTSD diagnosis incidence considered attributable to war zone service sharply increased from the beginning of the war to 2005–2007, remained fairly stable from 2005–2007 through 2011–2012, and then sharply decreased through 2012–2013 (war zone service, attributable incidence: 2003–2005, 2.5%; 2005–2007, 4.3%; 2011–2012, 4.3%; 2012–2013, 2.4%). War zone service was estimated to account for approximately four of five post-deployment PTSD diagnoses from the beginning of the war through 2005–2007 but continuously smaller proportions thereafter; by the end of the war period, war zone service was estimated

FIGURE 5. Attributable incidence rates (% of returnees affected), post-traumatic stress disorder (PTSD) diagnoses within 24 months after returning from Iraq/Afghanistan, by determinants of the likelihood of diagnosis, during specified follow-up periods, active component, U.S. Armed Forces, 2003–2013

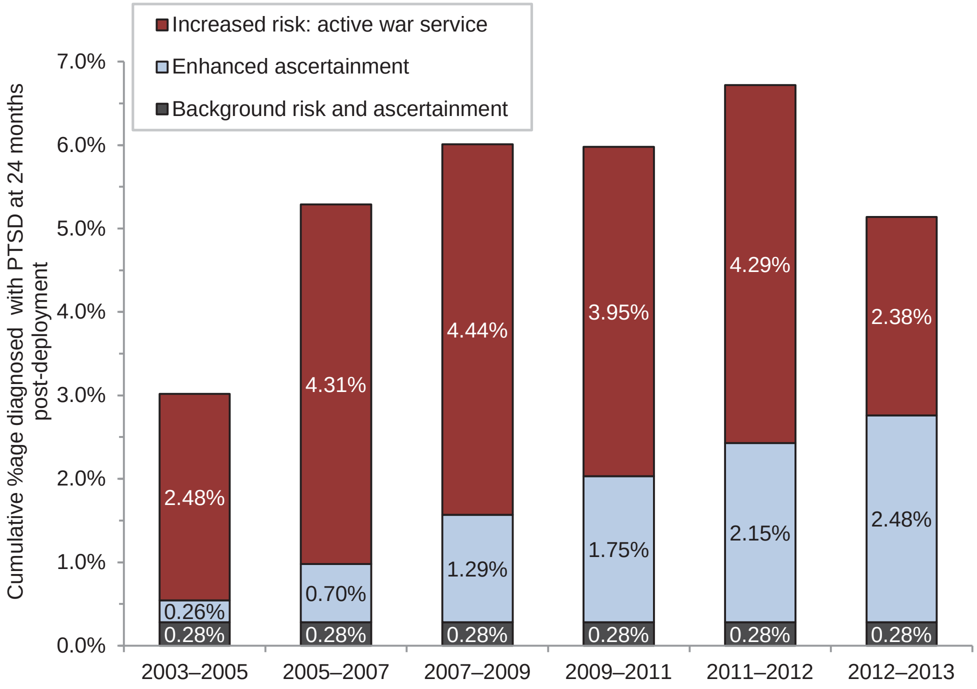
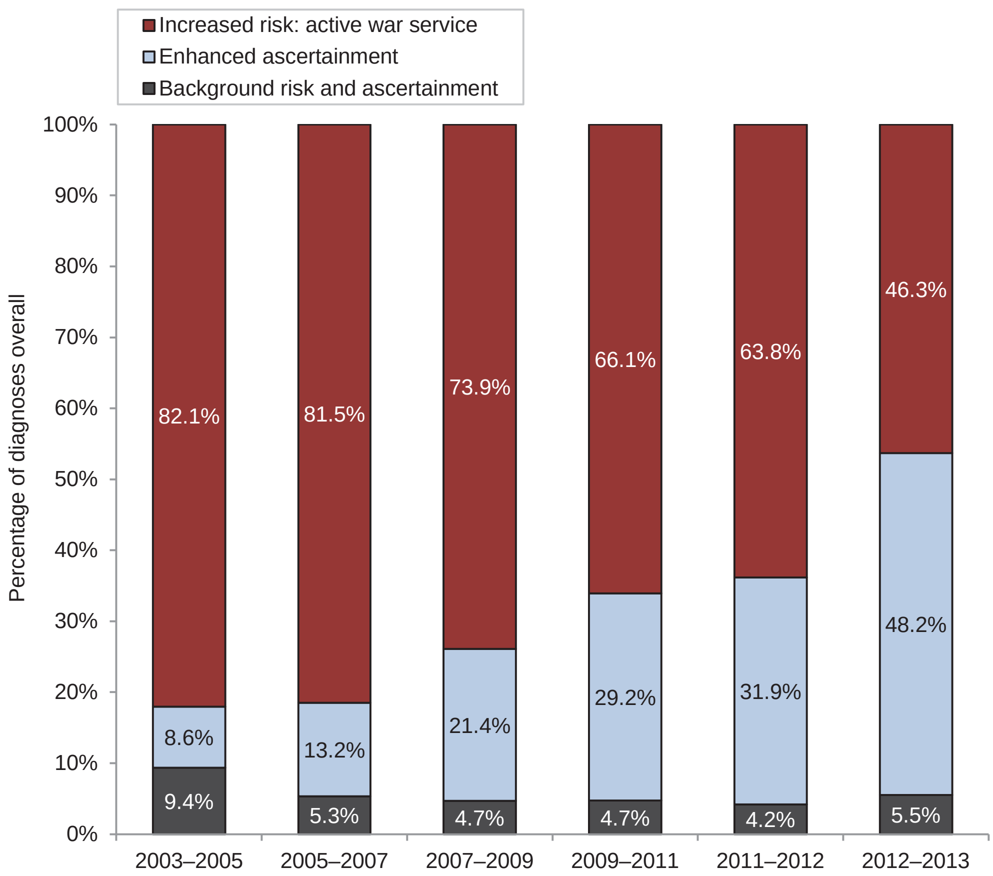


FIGURE 6. Attributable fractions (%) of post-traumatic stress disorder (PTSD) diagnoses within 24 months after returning from Iraq/Afghanistan, by determinants of the likelihood of diagnosis, during specified follow-up periods, active component, U.S. Armed Forces, 2003–2013



to account for less than half of all post-deployment PTSD diagnoses (war zone service, attributable fractions: 2003–2005, 82.1%; 2005–2007, 81.5%; 2012–2013, 46.3%) **(Figures 5, 6)**.

In three demographic/military subgroups of war zone deployers, the PTSD diagnosis incidence attributable to war zone service was estimated as at least 6.0% during at least one follow-up period: (war zone service, attributable incidence: Army, 2007–2009, 6.5%; combat-specific occupations, 2005–2007, 6.2%; medical occupations, 2005–2007 through 2012–2013, range, 6.1%–7.3%) **(Table 4b)**. (See https://www.afhsc.mil/documents/pubs/msmrs/2015/v22_n02_sup_1.pdf.)

In three subgroups of war zone deployers, the PTSD diagnosis incidence attributable to enhanced ascertainment was estimated as at least 3.0% during at least one follow-up period (enhanced ascertainment, attributable incidence: Army, 2009–2011 through 2012–2013, range, 3.2%–4.2%; older than 35 years old, 2011–2012, 3.8%; black, non-Hispanic, 2011–2012 and 2012–2013, 3.1% and 3.3%, respectively) **(Table 4b)**.

In four subgroups of war zone deployers, enhanced ascertainment was estimated to account for more than 50% of all post-deployment PTSD diagnoses during at least one follow-up period (enhanced ascertainment, attributable fractions: Army, 2012–2013, 60.5%; older than 35 years old, 2011–2012, 54.7%; black, non-Hispanic, 2012–2013, 57.1%; other than combat/healthcare occupations, 2012–2013, 51.8%) **(Table 4b)**.

EDITORIAL COMMENT

Among U.S. military members, TBI and PTSD occur quite frequently outside the context of warfighting. As such, the end of combat missions in Afghanistan and Iraq do not presage the end of new cases of TBI and PTSD among military members.

Although the end of warfighting will significantly reduce risks of TBI and PTSD among military members, the scopes and magnitudes of the effects of the end of warfighting are unclear. Throughout the war period, extensive programs and resources

were devoted to increasing mental health workers; reducing stigmas and removing barriers to seeking and receiving mental health care; and educating supervisors, family members, and primary care providers to the manifestations of TBI and PTSD. To the extent that such programs and dedicated resources continue, diagnosis rates during the post-war years are likely to greatly exceed those during the pre-war years.

The objectives of this report were to estimate the rates and proportions of post-deployment diagnoses of PTSD and TBI that could be attributed to each of three determinants of the likelihood of diagnosis considered here: the continuation of pre-war diagnosis experience, enhancements to case ascertainment that were implemented during the war period, and service in the Afghanistan/Iraq war zone. To these ends, analyses were designed to exploit the natural contrasts in risk exposures and case ascertainment capabilities experienced by deployers to Korea/Japan before the wars, deployers to Korea/Japan during the wars, and deployers to active war zones in Iraq/Afghanistan.

The findings indicate that the proportions of diagnoses attributable to each of the determinants of the likelihood of diagnosis considered here are quite different for TBI and PTSD and sharply vary across demographic and military subgroups and over time. For example, during most of the war period, war zone service was estimated to account for fewer than half of all post-deployment diagnoses of TBI, even though TBI diagnosis rates attributable to war zone service sharply increased from the beginning of the ground war in Iraq through 2007–2009 and then were fairly stable.

Rates and proportions of TBI diagnoses attributable to enhanced ascertainment also markedly increased during the war period. However, the increases did not begin until 2007–2009, approximately 4 years after the start of the ground war in Iraq and around the time that significant enhancements to TBI and PTSD-related policies, programs, and resources were implemented. By 2011–2012, pre-war diagnosis experience, enhanced case ascertainment, and active war zone service were estimated to account for fairly similar rates and proportions of all post-deployment TBI diagnoses.

The findings suggest that, if current policies, programs, resources, and institutional attitudes related to TBI case detection continue, the end of the wars in Afghanistan and Iraq will not decrease rates of TBI diagnoses to anywhere near pre-war levels. Because only diagnoses directly attributable to war zone service will be affected by ending combat operations, and because war service only accounted for slightly more than one third of all post-deployment TBI diagnoses in 2012–2013, diagnosis rates after the war may be as high as twice those before the war.

In regard to PTSD, on initial review, it seems counterintuitive that the proportions of diagnoses attributable to war zone service markedly declined during the war period, from more than 80% during the first 4 years after the ground war in Iraq began to less than 50% during the final years. However, during the same period, enhanced case ascertainment was estimated to account for steadily and markedly higher rates and proportions of diagnoses—from less than 10% during the first years after the ground war in Iraq began to nearly 50% during the final years. The findings suggest that enhanced PTSD case ascertainment policies and practices had large effects in military populations in general, not just among re-deployers from war zones. By the end of the war, enhanced ascertainment was estimated to account for nearly nine times more PTSD diagnoses than would be expected based on pre-war diagnosis experience. The findings suggest that rates of PTSD diagnoses after the war will be manyfold higher than those before the war.

During every period of the war except one, rates of PTSD diagnoses within 24 months post-deployment were higher among those in healthcare occupations than any other demographic or military-defined subgroup. Also, during every period of the war, rates of PTSD diagnoses attributable to war zone service were higher among those in healthcare occupations than in any other subgroup (including those in combat-specific occupations). Of note, throughout the war period, healthcare personnel had relatively low rates and proportions of PTSD diagnoses attributable to enhanced case ascertainment. The findings suggest that enhancements to PTSD case ascertainment that were implemented during the war had less impact on those in healthcare occupations than others. Perhaps, both before and throughout the war period, healthcare personnel were much less affected than others by stigmas, barriers, and difficulties accessing mental health services. If so, enhancements to case ascertainment that were implemented during the war may have had smaller effects on case diagnosis rates among healthcare workers than others. Finally, the findings reiterate that healthcare personnel in support of active combat operations have very high risk of clinically significant psychological morbidity after their war zone assignments end.

Finally, the findings of this report should be interpreted with consideration of the shortcomings of the analyses. For example, the analyses defined PTSD and TBI diagnoses based on reports of indicator diagnosis codes (per ICD-9-CM) during at least one ambulatory encounter or hospitalization in a fixed (e.g., not deployed or at sea) medical treatment facility. Such a method of case finding inevitably results in some “false positive” cases (e.g., diagnoses later ruled out) and missed true cases (e.g., diagnoses made in settings not covered by the case finding methods applied herein).

Also, service members who had ever been diagnosed with TBI/PTSD were ineligible for inclusion in post-deployment follow-up cohorts. However, as the war progressed, more mental health services were provided, and more TBI/PTSD diagnoses were made, in deployed settings. As more TBI/PTSD diagnoses were made in war zones, fewer war service veterans affected by TBI/PTSD received their initial diagnoses after re-deployment. As such, the rates and proportions of post-deployment incident diagnoses attributable to war zone service reported here document *post-deployment* incident diagnoses only, which do not include incident diagnoses made in the war zones.

In addition, some diagnoses made after assignments in Korea/Japan may have been

related to prior war zone service. In this analysis, such cases would not be attributed to war zone service and, hence, misclassified in relation to the determinants of the likelihood of diagnosis considered here

Finally, for many reasons, the "background" rates (based on pre-war experience) and rates attributable to enhanced ascertainment reported here may not be applicable throughout the post-war years. For example, if efforts and resources focused on TBI/PTSD case ascertainment decrease, diagnosis rates in the future may be much different from those estimated here. Still, the findings of this report provide insights that may be useful regarding the TBI- and PTSD-associated healthcare burdens of the future relative to those of the pre-war and wartime pasts.

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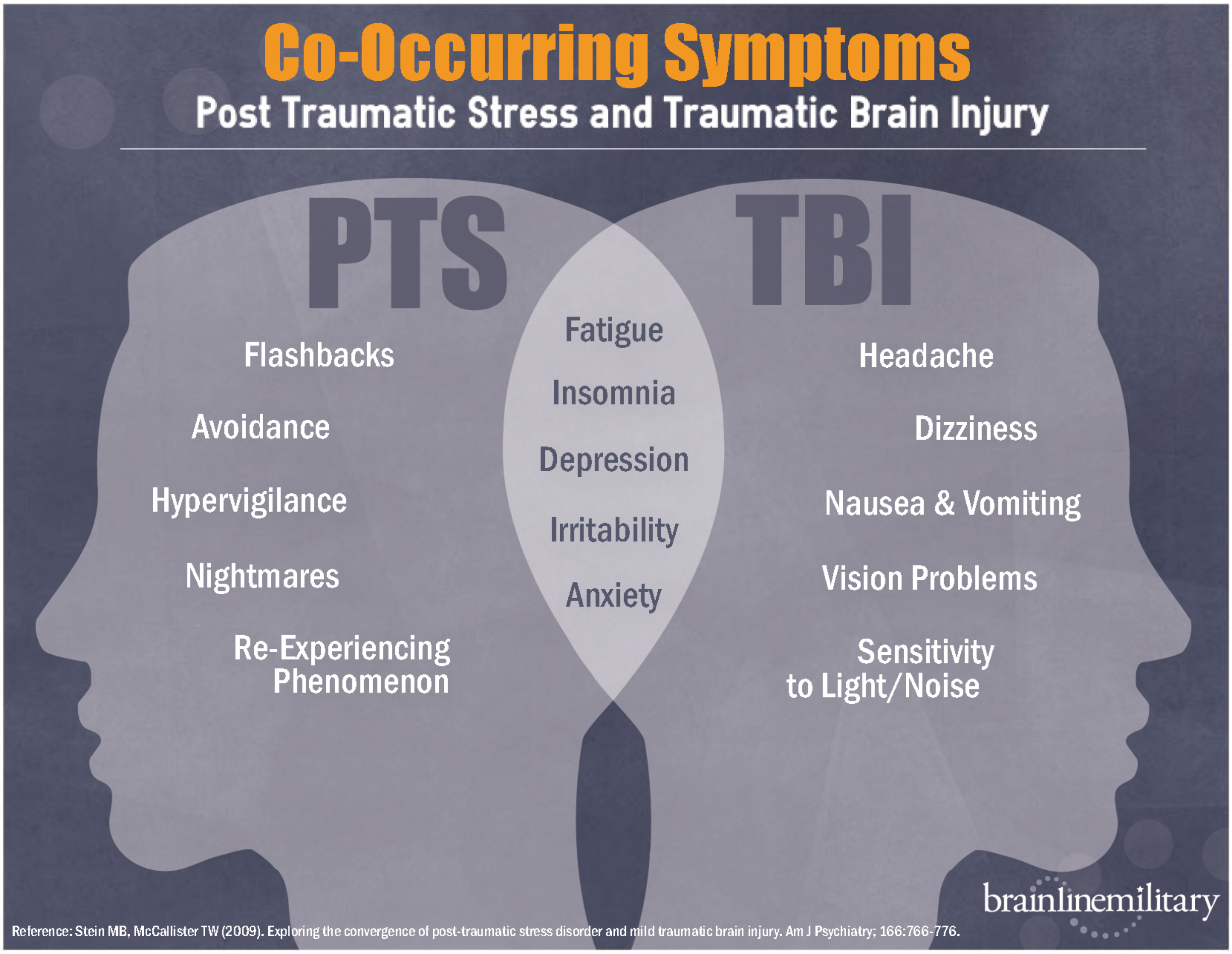


Surveillance Snapshot: Responses to the Traumatic Brain Injury (TBI) Screening Questions on the 2012 Version of the Post-Deployment Health Assessment (DD Form 2796)

FIGURE 1. Summary of responses to Question 10a

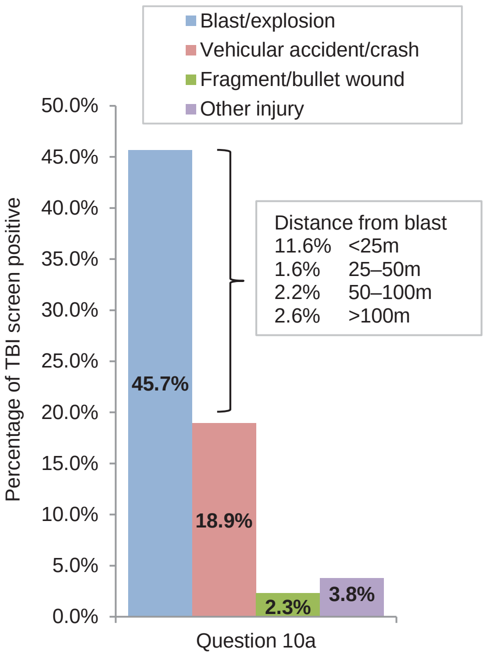


FIGURE 2. Summary of responses to Question 10b

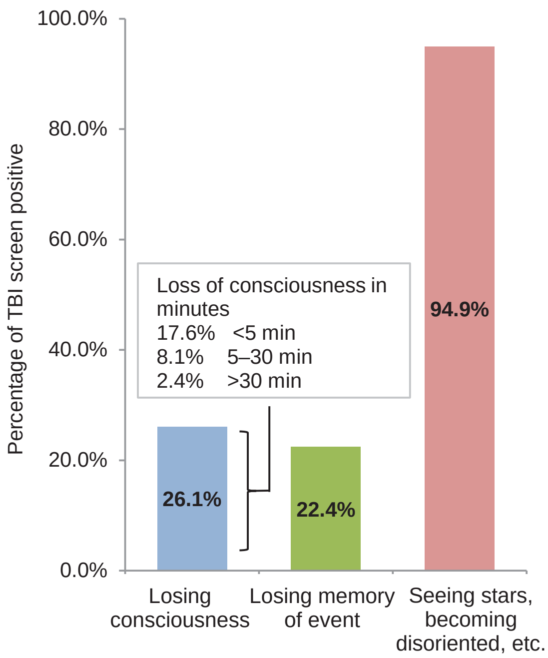
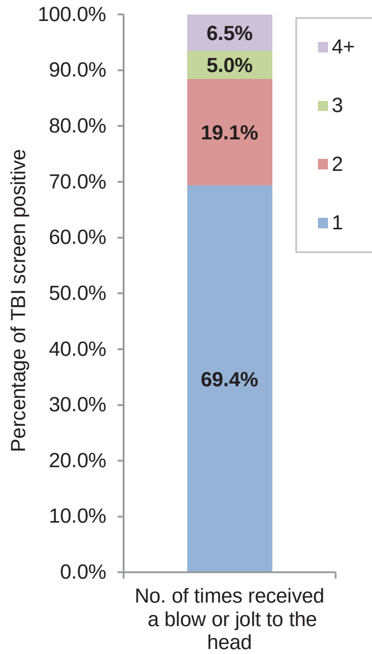


FIGURE 3. Summary of responses to Question 10c



Completion of a Post-Deployment Health Assessment (PDHA) (DD Form 2796) is required for all service members returning from an operational deployment that required completion of a Pre-Deployment Health Assessment (DD Form 2795), and includes a face-to-face interview with a healthcare provider. Screening for deployment-related traumatic brain injury (TBI) was implemented in the PDHA in 2008. The current version of the form (dated September 2012) includes additional TBI-related questions intended to provide more detail about possible TBI events during deployments.[1]

This analysis summarized responses to questions on the DD Form 2796 (2012 version) related to TBI screening **(sidebar)**. All forms completed since the implementation of this version were examined; the most recent form completed by a military member was preferentially retained. A positive TBI screen was defined as a positive response to at least one item in Question 10a and a positive response to at least one item in Question 10b. Of 367,555 service members with completed forms, 8,127 (2.2%) had a positive TBI screen according to these criteria. Of those with a positive TBI screen, 3,711 (45.7%) reported exposure to a blast or explosion; of those who reported their distance from the blast, the majority reported it was less than 25 meters **(Figure 1)**. Most (94.9%) reported seeing stars or becoming disoriented; approximately one-fifth of respondents (22.4%) reported losing memory of the event and more than a quarter (26.1%) reported losing consciousness. Relatively few respondents (n=597) reported the length of loss of consciousness; of those who did, the majority reported less than 5 minutes **(Figure 2)**. A total of 2,485 service members (30.6%) reported more than one concussive event (i.e., blow or jolt to the head) during the deployment **(Figure 3)**.

1. Enhanced Post-Deployment Health Assessment (PDHA) Process (DD Form 2796). Deployment Health Clinical Center website: http://www.pdhealth.mil/dcs/DD_form_2796.asp. Accessed on 25 February 2015.

Questions on the DD Form 2796 (2012 version) related to TBI screening

10.a. During this deployment, did any of the following events happen to you? (Mark all that apply)

(1) Blast or explosion (e.g., IED, RPG, EFP, land mine, grenade, etc.)? O Yes O No
If yes, please estimate your distance from the closest blast or explosion:
O Less than 25 meters (82 feet)
O 25-50 meters (82-164 feet)
O 50-100 meters (164-328 feet)
O More than 100 meters (328 feet)

(2) Vehicular accident/crash (any vehicle including aircraft)? O Yes O No

(3) Fragment wound or bullet wound?
a. Head or neck O Yes O No
b. Rest of body O Yes O No

(4) Other injury (e.g., sports injury, accidental fall, etc.)? O Yes O No

If yes to any of the above, please explain: ______________________________

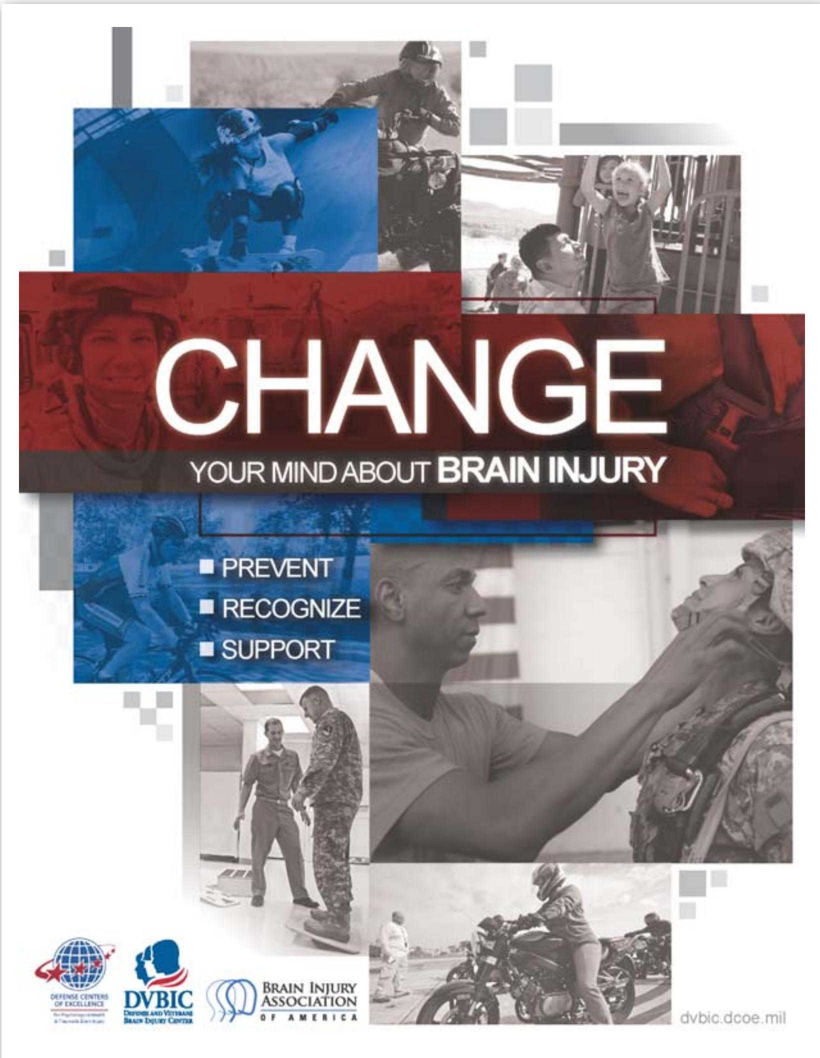
10.b. As a result of any of the events in 10.a., did you receive a jolt or blow to your head that IMMEDIATELY resulted in:

(1) Losing consciousness ("knocked out")? O Yes O No
If yes, for about how long were you knocked out?
O Less than 5 min O 5-30 min O more than 30 min

(2) Losing memory of events before or after the injury? O Yes O No

(3) Seeing stars, becoming disoriented, functioning differently, or nearly blacking out? O Yes O No

10.c. How many total times during this deployment did you receive a blow or jolt to your head?
(only answer if you had a yes to any of the questions on 10a.)
O 0 O 1 O 2 O 3 O more than 3 (list number of times) ______________



Measles and Mumps Among Service Members and Other Beneficiaries of the U.S. Military Health System, January 2007–December 2014

Denise O. Daniele, MS; Leslie L. Clark, PhD, MS; Devin J. Hunt, MS; Francis L. O'Donnell, MD, MPH (COL, USA, Ret)

Measles and mumps are highly communicable infectious diseases whose causative viruses are spread through airborne droplets and infected surfaces. Individuals at highest risk are infants and unvaccinated individuals. Despite effective vaccines, there have been recent increases in incidence in the U.S. of both infections. During the surveillance period, there were 14 confirmed measles cases and 99 confirmed mumps cases among U.S. military members and other beneficiaries of the U.S. Military Health System. Only one of the confirmed cases of measles was in a service member. Children aged 5 years and younger accounted for the greatest proportion of confirmed measles cases (50.0%); the greatest proportions of confirmed mumps cases were for children aged 1–5 years and adults aged 26–30 years (22.2% and 17.2%, respectively). California had more cases of both measles and mumps than any other state. Recent trends in measles and mumps in civilian populations in the U.S. highlight the importance of primary and booster vaccinations.

Measles, or rubeola, is a highly communicable viral disease that spreads through respiratory droplets in the air or by contact with contaminated surfaces. The clinical course of measles begins with mild nonspecific symptoms (fever, cough, runny nose, conjunctivitis, sore throat) lasting 2–3 days; tiny white spots (Koplik spots) may also develop inside the mouth. This stage is followed by the development of a maculopapular rash (small, slightly raised red spots) and a high fever. Complications of measles occur in about one-third of cases and can include ear infection, inflammation of the respiratory tract (e.g., bronchitis, pneumonia), encephalitis, and thrombocytopenia (low platelet count). Measles virus is particularly dangerous for unvaccinated pregnant women because of the risk of pregnancy loss and preterm labor.[1,2]

Mumps virus spreads easily from person to person through inhalation of airborne saliva droplets or from contact with objects (e.g., utensils, toys) contaminated by the saliva of an infected person. Mumps virus primarily affects the parotid glands, which are saliva-producing glands located in front of the ears. Swelling in one or both of the parotid glands is the classical presentation of mumps infection, along with fever, headache, fatigue, and loss of appetite. Severe complications are rare but include inflammation of other parts of the body such as testicles, pancreas, ovaries, breasts, or the brain (encephalitis) or meninges (meningitis).[3]

Both measles and mumps were common in the U.S. until the introduction of licensed vaccines for measles (1963) and mumps (1967); since then, these vaccines have been important components of routine pediatric preventive care. Individuals at highest risk for measles and mumps infections are infants (because they are too young to be vaccinated), unvaccinated or inadequately vaccinated persons, individuals living in communities with low vaccination rates or in crowded, unsanitary conditions, and persons with compromised immune systems. Although the numbers of cases of measles and mumps dramatically decreased after vaccine implementation, outbreaks of measles and mumps occur sporadically in the U.S. and are becoming more common. In 2014, a total of 644 cases of measles linked to 23 outbreaks in 27 U.S. states were reported.[4] Cases of measles more than doubled between 2013 and 2014. Thus far in 2015, a total of 154 cases have been reported from 17 states, and most of those cases have been linked to an outbreak that started at an amusement park in California.[4–6] The majority of these cases occurred in individuals who were unvaccinated.

Mumps outbreaks continue to occur in the U.S., even among vaccinated individuals and in areas with high vaccination rates. Protection against mumps is 88% effective with two doses of the vaccine. When mumps infection does occur in vaccinated individuals, the disease is usually less severe; moreover, outbreaks tend to be of limited duration in communities with high vaccination rates.[7] Most cases occur in group settings where individuals have close contact with infected individuals (e.g., schools, insular religious communities). In 2014, a total of 1,151 cases were reported in the U.S.—one outbreak of note was linked to individuals associated with professional hockey teams.[7,8]

This report summarizes the numbers, trends, and demographics of measles and mumps diagnoses among service members and other beneficiaries of the U.S. Military Health System (MHS).

METHODS

The surveillance period was 1 January 2007 through 31 December 2014. The surveillance population consisted of all individuals who were beneficiaries of the MHS (i.e., active and reserve component service members, retired service members, family

members and other dependents of service members and retirees, and other authorized government employees and family members). It is Department of Defense policy that cases of measles and mumps (as well as many other diseases of public health importance) be reported electronically through military health channels for surveillance purposes.[9] Conditions covered by this policy are referred to as reportable medical events (RMEs). In this article, the term RME is used as shorthand for such a report submitted for a case of measles or mumps.

For this analysis, a "confirmed" case was defined as an individual identified through an RME of measles or mumps that was described as confirmed by meeting specified laboratory or epidemiologic criteria.[10] A "possible" case was defined as: 1) an RME of measles or mumps without laboratory or epidemiologic confirmation; or 2) a record of an inpatient or outpatient medical encounter with a diagnosis of measles (ICD-9-CM: 055) or mumps (ICD-9-CM: 072) in the primary diagnostic position and an associated symptom code listed in another diagnostic position. Encounters were excluded if there was either: 1) a record of measles or mumps vaccine administration or a positive test for serologic immunity to measles or mumps within 7 days before or after the encounter date; or 2) an ICD-9-CM, procedure, or Current Procedural Terminology (CPT) code indicating measles or mumps vaccination or antibody testing recorded for the same encounter as the diagnosis of measles or mumps. The reporting of results of this analysis focused on confirmed cases. All data used to ascertain cases were derived from the electronic records of the Defense Medical Surveillance System (DMSS).

TABLE 1. Confirmed and possible cases of measles and mumps among beneficiaries of the Military Health System, January 2007–December 2014

	Measles		Mumps	
	Confirmed	Possible	Confirmed	Possible
Total	14	53	99	228
Active component	1	2	37	31
Reserve component	0	0	6	9
All other beneficiaries	13	51	56	188
Sex[a]				
Male	6	29	58	114
Female	8	22	39	113
Service				
Army	0	1	12	14
Navy	0	1	10	10
Air Force	1	0	20	12
Marine Corps	0	0	1	1
Coast Guard	0	0	0	3

[a]The gender was unknown in two confirmed mumps cases, two possible measles cases, and one possible mumps case.

RESULTS

Confirmed cases

Measles: During the surveillance period, there were 14 confirmed cases of measles among all beneficiaries of the MHS **(Table 1, Figure 1)**. The only confirmed case of measles in a service member was in an active component Air Force member diagnosed in April 2014 in California. The

FIGURE 1. Confirmed cases of measles among beneficiaries of the Military Health System, January 2007–December 2014

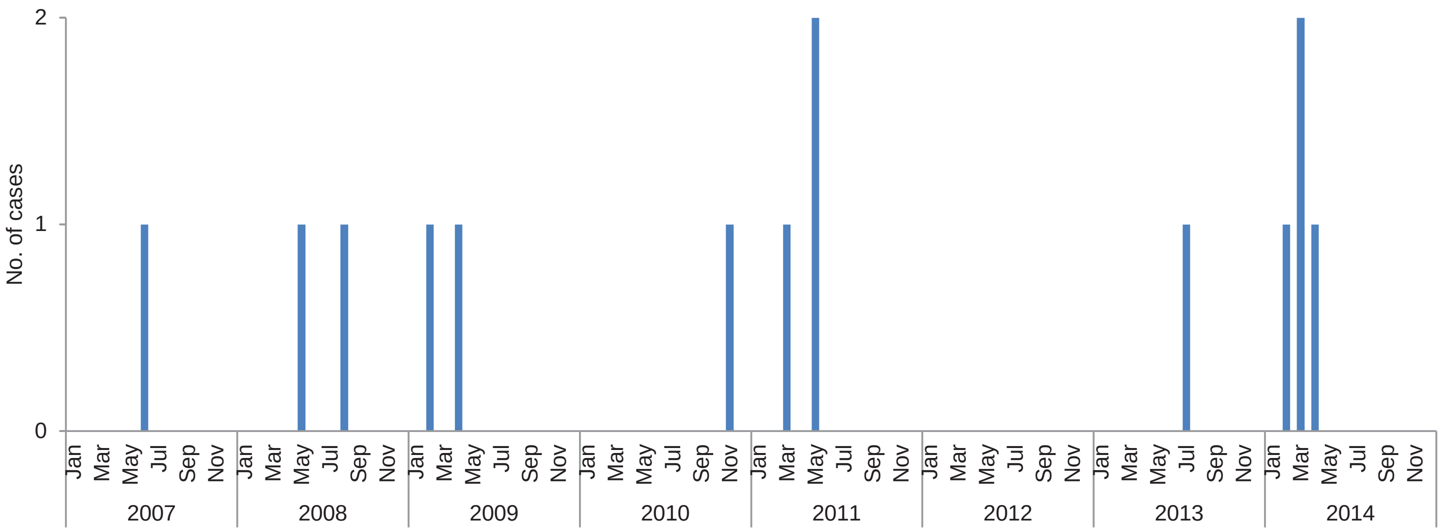
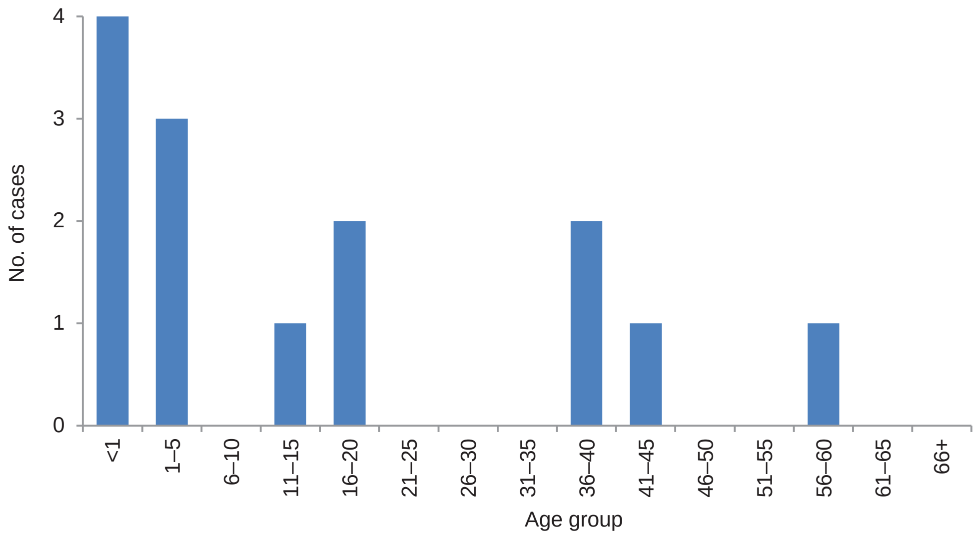


FIGURE 2. Age distribution of confirmed cases of measles among beneficiaries of the Military Health System, January 2007–December 2014



remaining 13 confirmed cases were among non-service member beneficiaries.

More confirmed cases were reported in 2014 (n=4) than in any other year of the period **(Figure 1)**. All four cases in 2014 were among beneficiaries diagnosed in California **(data not shown)**. Of all 14 cases reported during the 8-year surveillance period, seven (50.0%) were in children younger than 5 years old; of these children, four were younger than 1 year old, two were 1 year old, and one was 4 years old **(Figure 2)**.

Mumps: During the surveillance period, there were 99 confirmed cases of mumps among all beneficiaries **(Table 1, Figure 3)**. There were 37 cases among active component service members and six among reserve component service members. Among the Services, the Air Force had the greatest number of confirmed cases (n=20). The remaining 56 cases of mumps were among non-service member beneficiaries.

There were more confirmed cases in 2010 (n=23) than in any other year of the period **(Figure 3)**. During the entire surveillance period, the single month with the highest number of mumps cases was March of 2010 (n=5). The locations reporting the most cases were Japan (n=11) and California (n=10) **(data not shown)**. The age groups with the most confirmed cases were children aged 1–5 years (n=22; 22.2%) and adults aged 26–30 years (n=17; 17.2%) **(Figure 4)**.

Possible cases

Measles: During the surveillance period, there were 53 possible cases of measles among all beneficiaries of the MHS **(Table 1)**. Two of the possible cases were among service members. The remaining 51 possible cases were among non-service member beneficiaries; of these, 25 (47.2%) affected children aged 5 years and younger **(data not shown)**.

Mumps: During the surveillance period, there were 228 cases of possible mumps among all beneficiaries of the MHS **(Table 1)**. Most of the possible cases (n=188) affected non-service member beneficiaries.

Of the 40 possible cases among military members, 31 affected active

FIGURE 3. Confirmed cases of mumps among beneficiaries of the Military Health System, January 2007–December 2014

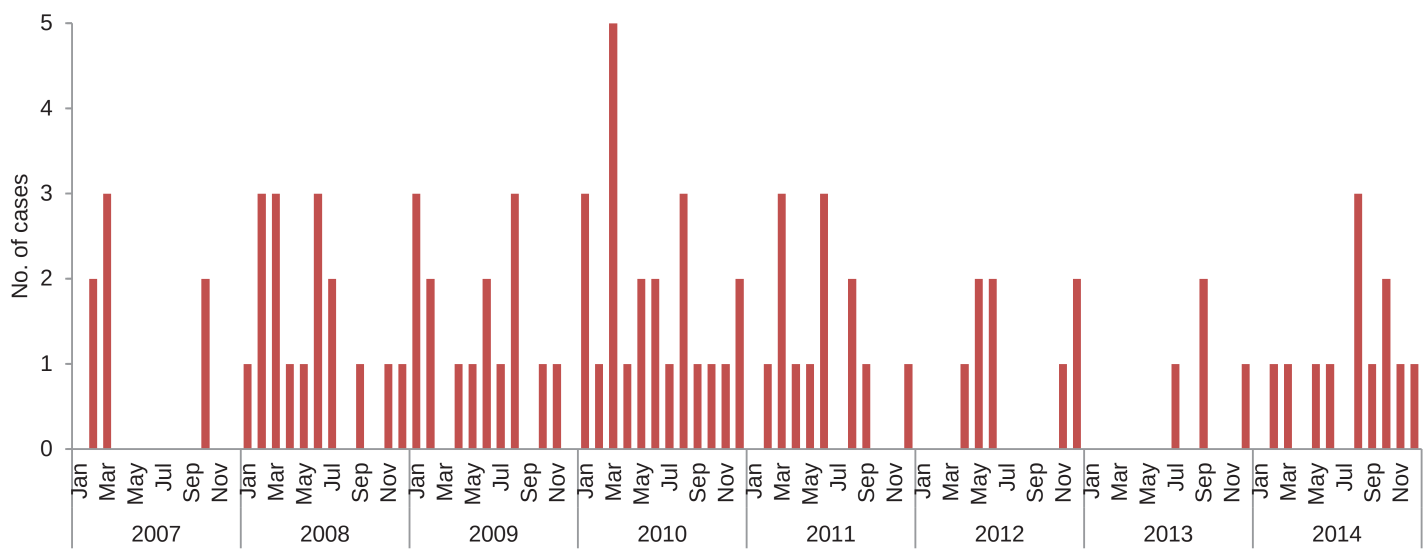
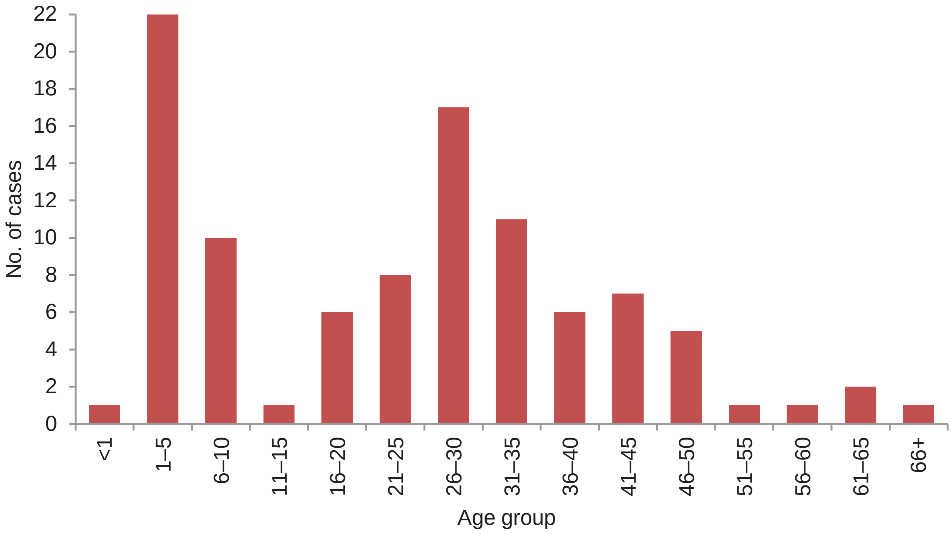


FIGURE 4. Age distribution of confirmed cases of mumps among beneficiaries of the Military Health System, January 2007–December 2014



component and nine affected reserve component members. Overall, there were more possible cases among Army (n=14) than any other Service.

EDITORIAL COMMENT

Receipt of the measles-mumps-rubella (MMR) vaccine is required for entry into military service; however, measles and mumps can still occur in vaccinated individuals due to primary vaccine failure or waning immunity. During the 8-year surveillance period of interest for this report, only one confirmed measles case was reported among service members. The report of the case (as an RME) noted that the individual had only one dose of MMR vaccine on record; public health follow-up of the case included identifying and vaccinating other service members with only one MMR vaccination on record.

Most of the confirmed cases of measles identified for this report affected non-service member beneficiaries. Children aged 4 years or younger accounted for half (n=7) of all confirmed measles cases. This finding and several published reports of recent outbreaks suggest that some children who have not received two doses of MMR vaccine are susceptible to infection when exposed to measles virus.[4,5,11] Of note in this regard, a second dose of MMR vaccine is recommended for children aged 4–6 years.[12]

In contrast to the experience of the MHS regarding measles, there were relatively more confirmed cases of mumps (43.4%) among service members. This is not surprising because the efficacy of the mumps vaccine (88% with two vaccinations) is lower than that of measles vaccine. Additionally, a relatively high number of confirmed cases of mumps occurred in 26- to 30-year-olds. This observation is compatible with evidence that vaccine-associated immunity against mumps virus wanes over time.[13–15]

It should be noted that this analysis did not attempt to ascertain the vaccination status of the measles and mumps cases. As a result, it is not possible to determine what proportions of the non-service member cases were unvaccinated or inadequately vaccinated against measles and mumps.

In this analysis, the location associated with the greatest number of measles and mumps cases in MHS beneficiaries was California. It is unknown whether these cases were associated with outbreaks within military or civilian communities.

Many "possible" cases of measles and mumps were identified in this analysis. In the MHS, measles and mumps are diagnoses that require RME notifications. The published guidelines state: "Timely, accurate reporting of probable, suspected, or confirmed cases ensures proper identification, treatment, control, and follow-up of cases."[9] Moreover, the guidelines discourage delaying the submission of RME reports while awaiting laboratory confirmation and call for the transmission of additional reports when confirmation of the diagnosis has been achieved. In the context of these guidelines, this analysis searched the database of RMEs for cases that were identified as "confirmed." RMEs that characterized the diagnoses as "probable" or "suspected" and were never amended as "confirmed" were treated as "possible" cases. Such cases were grouped with cases identified from records of inpatient and outpatient records (as described in the Methods section). As a result, "possible" cases may include both "true" cases for which there were no follow-up RMEs indicating confirmation; and "true" cases for which diagnoses were documented in inpatient or outpatient records but no RMEs were ever transmitted by local military public health officials. Civilian healthcare providers who diagnose and confirm cases of measles and mumps outside of the MHS would not be expected to transmit RME reports; however, the diagnoses are captured in the DMSS if such care is underwritten by the MHS. The circumstances described above may result in the underestimation of the actual incidence of measles and mumps among MHS beneficiaries.

On the other hand, other circumstances may tend to produce overestimates of incident cases. For example, diagnoses of measles and mumps recorded in health records may represent misdiagnoses, tentative ("rule out") diagnoses that are not confirmed, miscoding of encounters for vaccinations or laboratory testing, and erroneous entries of diagnosis (ICD-9-CM) codes. In summary, the counts of MHS beneficiaries whose diagnoses were categorized as "possible" cases of measles or mumps are fraught with uncertainty. For that reason, this report concentrated on "confirmed" cases whose counts are more reliable.

Recent trends in measles and mumps in both military and civilian populations in the U.S. highlight the importance of primary and booster vaccinations. Current

recommendations for the MMR vaccine include two doses, the first between ages 12 and 15 months and the second between ages 4 and 6 years. Adults with only one dose or who lack laboratory evidence for measles, mumps, and/or rubella immunity are encouraged to receive the vaccine, particularly for those who work in the healthcare setting.[12] Because service members are required to have evidence of immunity for measles and mumps, it is not surprising that active and reserve component members account for only a small proportion of all cases of measles and mumps in the MHS.

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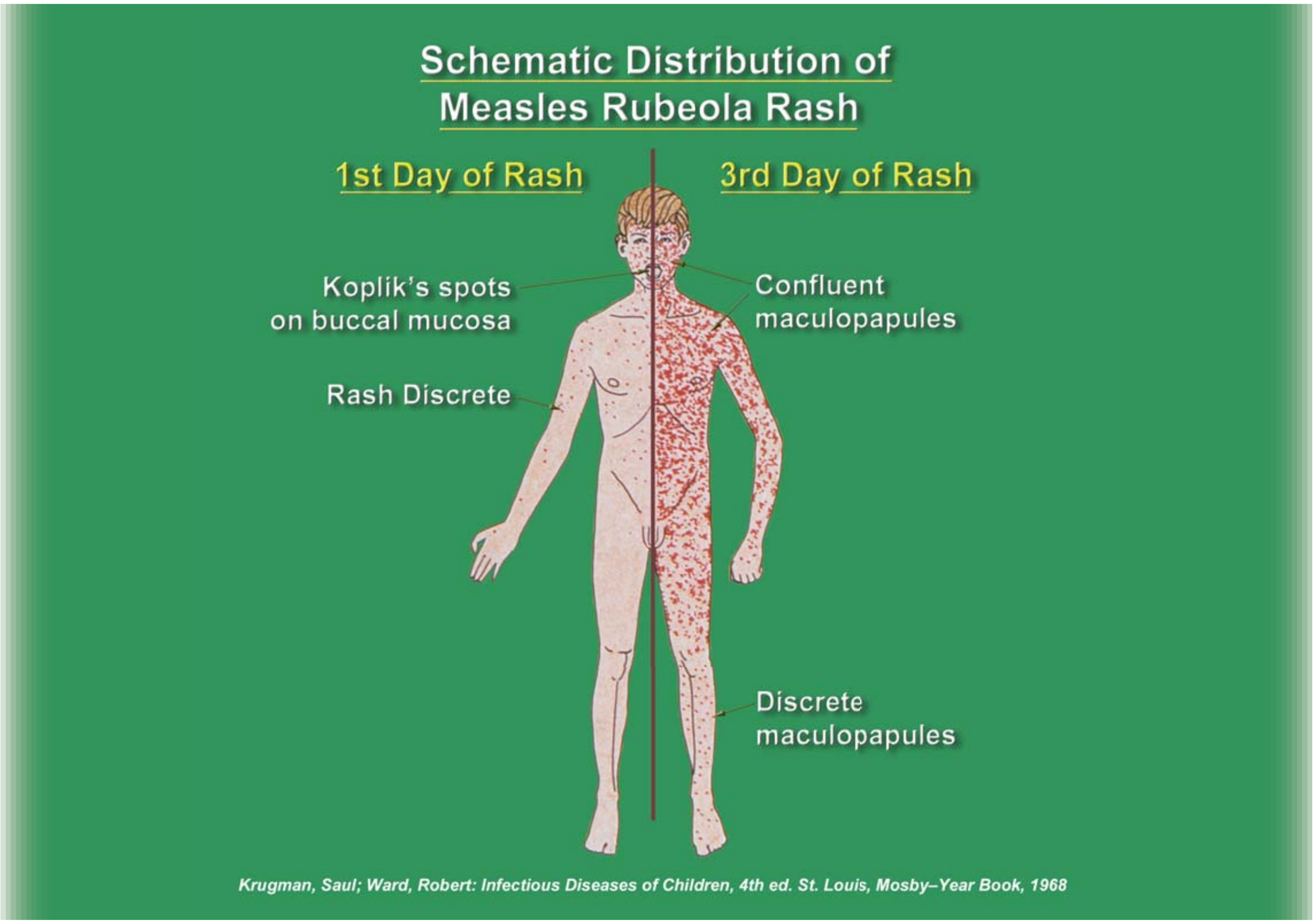
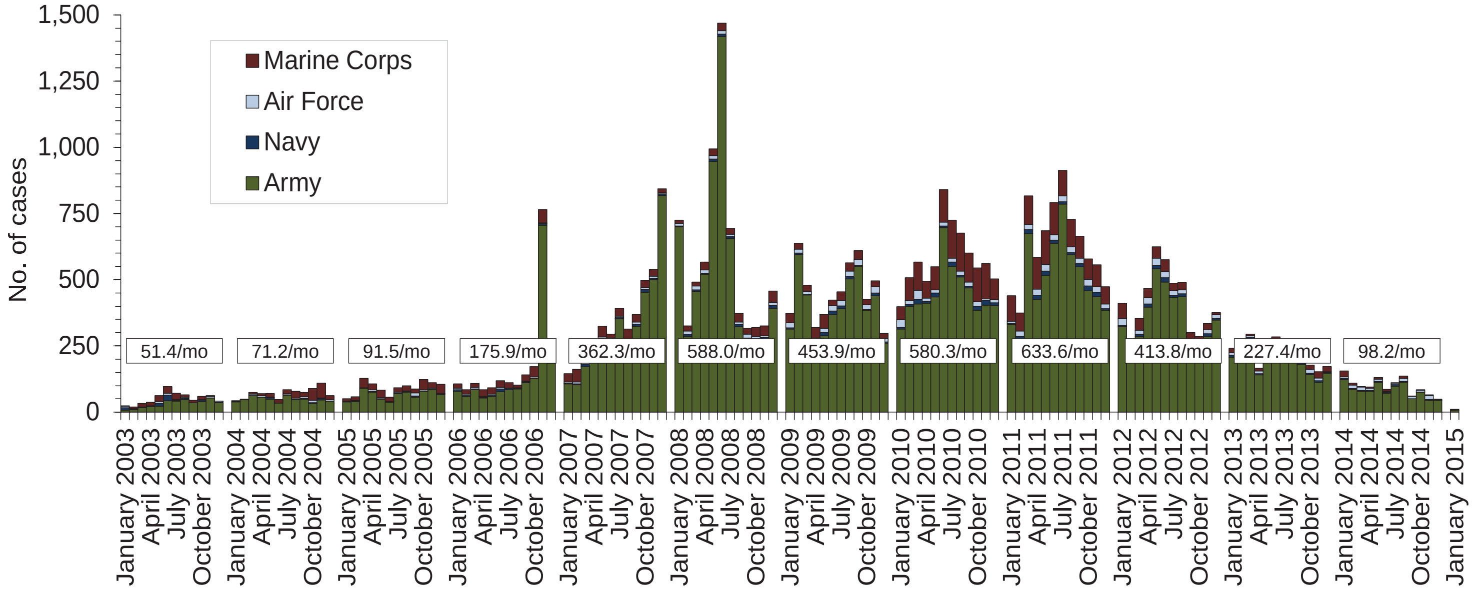


Deployment-related Conditions of Special Surveillance Interest, U.S. Armed Forces, by Month and Service, January 2003–January 2015 (data as of 18 February 2015)

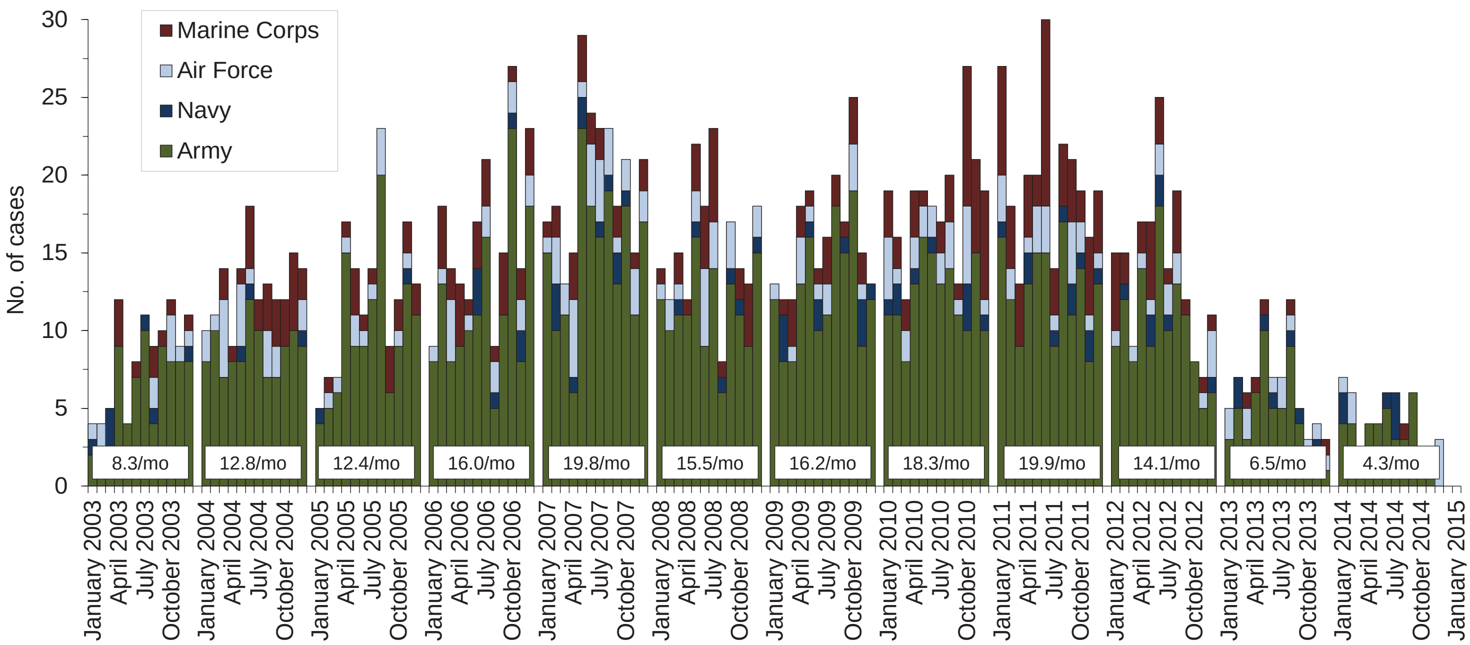
Traumatic brain injury (TBI) (ICD-9: 310.2, 800–801, 803-804, 850–854, 907.0, 950.1–950.3, 959.01, V15.5_1–9, V15.5_A–F, V15.52_0–9, V15.52_A–F, V15.59_1–9, V15.59_A–F)[a]



Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. 2009;16(12):2–8.

[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from deployment (includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 4,540 deployers who had at least one TBI-related medical encounter any time prior to deployment).

Deep vein thrombophlebitis/pulmonary embolus (ICD-9: 415.1, 451.1, 451.81, 451.83, 451.89, 453.2, 453.40–453.42 and 453.8)[b]



Reference: Isenbarger DW, Atwood JE, Scott PT, et al. Venous thromboembolism among United States soldiers deployed to Southwest Asia. *Thromb Res*. 2006;117(4):379–383.

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from deployment.

Medical Surveillance Monthly Report (MSMR)
Armed Forces Health Surveillance Center
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MEDICAL SURVEILLANCE MONTHLY REPORT (MSMR), in continuous publication since 1995, is produced by the Armed Forces Health Surveillance Center (AFHSC). The *MSMR* provides evidence-based estimates of the incidence, distribution, impact and trends of illness and injuries among United States military members and associated populations. Most reports in the *MSMR* are based on summaries of medical administrative data that are routinely provided to the AFHSC and integrated into the Defense Medical Surveillance System for health surveillance purposes.

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ISSN 2158-0111 (print)
ISSN 2152-8217 (online)